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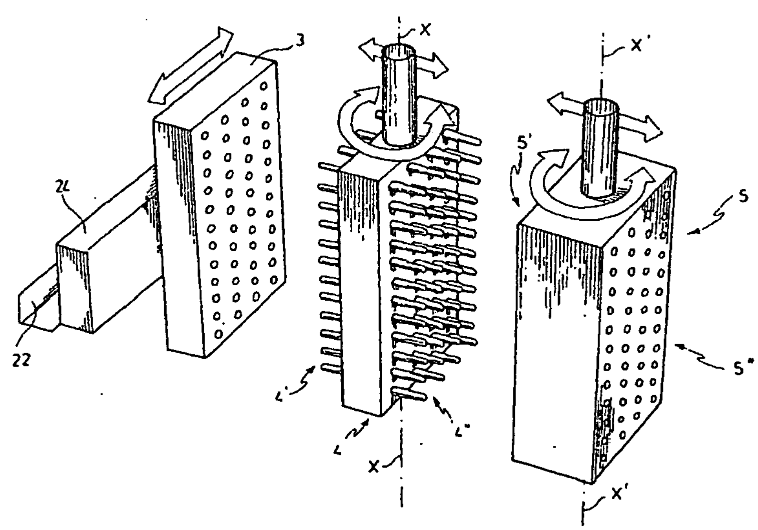
(54) Title: HANDLING AND COOLING DEVICE FOR PREFORMS




(57) Abstract: The present invention relates to a preform handling and cooling device (4, 5), particularly for preforms made of PET, which can take the preforms from a holding device (3, 4) disposed outside the moulding region of a press. The handling and cooling device (4, 5) can translate towards the holding device (3, 4), take the preforms, holding them on a portion (4', 5') which faces the holding device (3, 4), return to its previous position, and rotate so as to turn towards the holding device a further portion (4'', 5'') of the handling and cooling device (4, 5) which was not previously facing it. The handing and cooling device also has means for cooling the preforms. The device enables the preforms to be discharged at a temperature suitable for preventing mutual adhesion between the preforms in the storage containers, by means of a compact structure and with small operating spaces.

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# DESCRIPTION

## Handling and cooling device for preforms

The present invention relates to a preform handling and cooling device, in particular for handling and cooling preforms made of thermoplastic material which are subsequently to be processed to produce bottles and the like.

Blown bottles made of thermoplastic material, substantially of polyethylene terephthalate (PET), are produced by the stretch blow-moulding of suitable bodies of elongate, tubular shape, which are open at one end, known as the mouth, and are closed at the opposite end, known as the base. These bodies, which are known by the term "preforms" are generally produced by injection-moulding in suitable presses.

The preforms may be transported in containers and sent to the bottle-blowing plants which are often located near water sources or on beverage-producers' premises (two-stage technique), or may be subjected to stretch blow-moulding directly (single-stage technique) if the preform-production plant is combined with a stretch blow-moulding plant.

Irrespective of whether the single-stage or the two-stage technique is used, the preforms are produced by an injection-moulding press. The press has a mould provided with cavities, known as the female mould, and a movable complementary mould, known as the male mould, which has cylindrical elements to be associated with the cavities of the female mould.

In the configuration in which the male mould is engaged in the female mould, a tubular cavity is formed between the cavity of the mould and the cylindrical elements of the male mould and the plastics material is injected therein in suitable temperature and pressure conditions.

Upon completion of the injection, the male mould is disengaged from the female mould by moving away from it. The preforms remain associated with the cylindrical elements of the male mould.

The cooling of the preforms, both inside the mould and whilst they remain on the cylindrical elements of the male mould, plays a fundamental part in the production of preforms which can withstand the stretch blow-moulding process without complications.

PET in fact shows a tendency to crystallize, adopting an opaque appearance and rendering the preform brittle and hence not suitable for stretch blow-moulding processes.

The PET crystallization-rate is practically zero at the melting point (indicated Tm, generally between 245° and 260°C) and below the glass transition point (indicated Tg, between 70° and 80°C), and is at a maximum between 160° and 185°C (the maximum crystallization-rate temperature, Tcc).

For a process condition in which crystallization is absent it is therefore necessary, after the step of the compacting of the plastics material in the mould, to cool the preform as quickly as possible both in the mould and on the cylindrical elements of the male mould, in order to bring it to a temperature close to Tg.

Moreover, it is necessary to cool the preforms adequately before they are discharged into the storage or transportation containers, to prevent the preforms disposed close to the bottom of the containers being deformed or giving rise to mutual cohesion phenomena under the weight effect of other preforms and of a temperature which is kept high by the presence of the accumulated preforms.

To prevent the PET-crystallization process, the cooling of the preforms is generally started upon completion of the compacting of the plastics material in the mould, the cooling being forced by the provision of internal systems for cooling the cavities of the mould, generally with water, preferably in conditions of turbulence.

In order to continue the preform-cooling process when the preforms are held on the cylindrical elements of the male mould, the preforms may be kept on these elements until they have cooled completely, but this prevents the execution of further moulding cycles and considerably reduces the productivity of the plant.

Moreover, because of the considerable shrinkage exhibited by the thermoplastic material during cooling, the preforms would tighten onto the cylindrical elements of the male mould, creating considerable problems in disengaging them from the male mould, due to sticking of the preforms on the male elements.

It is known, however, to provide, in the plant, an extraction system composed of a mould extractor and an extraction and cooling manipulator which cooperate to take the preforms from the male mould in the moulding region of the press, housing them in suitable cavities of the

extraction manipulator which, by translating, transfers the preforms to a cooling region outside the moulding region.

In this connection, it is useful to state that the preforms perform a predetermined number of "cooling cycles", meaning that before the preforms are discharged, they are held by an extraction or cooling manipulator for a period of time such as to allow the press to perform that predetermined number of moulding cycles.

In other words, if it is stated that, in a particular plant, the preforms perform, by way of example, two cooling cycles, it is intended to indicate that, before the preforms are discharged, they are held on a cooling or extraction plate whilst the press performs two moulding cycles.

It is known to produce a preform-production machine which has a press, provided with a mould and a male mould, and an extraction manipulator which takes the preforms from the male mould and carries them into a cooling region outside the moulding region.

The male mould of the press is thus left free, enabling further moulding cycles to be performed whilst the process of the cooling of the preforms on the extraction manipulator continues, before the preforms are discharged onto the conveyor belt to be sent to the containers.

A machine of the type described above is known from the document US 4,721,452.

Further manipulators may be provided, in accordance with structural and functional methods similar to those described above, to cooperate with the extraction manipulator, holding the preforms for further cooling, leaving the extraction

manipulator free so that further preforms can be extracted from the male mould upon completion of a further moulding cycle.

It is known, for example, to produce a preform-production plant in which the press has a mould and a male mould which are arranged vertically.

A female extraction manipulator can cooperate with the male mould, taking the preforms therefrom and carrying them to a cooling region outside the moulding region.

The extraction manipulator can translate in a further direction, perpendicular to the direction of its extraction movement from the male mould, cooperating with a further male plate which holds the preforms before discharging them onto a conveyor belt.

The preform-production plant described above has the disadvantage of providing an extraction manipulator and a cooling plate which cooperate by being disposed one above the other by means of a translational movement characterized by a large travel.

In fact, in order for the extraction manipulator to be able to transfer the preforms to the cooling plate, the two plates must be superimposed and considerable translations of the extraction manipulator are therefore necessary.

A plant of the type described is included, for example, in the document WO 99/58313.

To bring about a translational movement with considerable travel such as that which characterizes the machine of the description given above leads to the machine having a

considerable area in plan. In other words, a machine of the type described occupies a considerable amount of space in the plant since it is necessary to provide sufficient space to allow for the movements of the cooling plate.

Moreover, the machine described above has to be equipped with the devices necessary to permit considerable movements of the cooling plate, such as tracks for the extraction manipulator, tracks for supporting the cooling plate, and the like.

It is also known to use an extraction manipulator associated with a cooling plate which enables a further cooling plate to be engaged, by means of a rotation.

For example, it is known to produce a preform-production machine which provides an extraction manipulator, a rotary cooling plate, and a further, translatory cooling plate.

However, the machine described has the disadvantage of providing a translatory cooling plate which, in order to take the preforms from the rotary cooling plate, still needs to perform an extensive translation in order to be disposed above on the rotary cooling plate.

A machine of the type described is known from the document WO 00/24562.

There is therefore a need to provide, within a preform-production plant, a device for handling and cooling preforms which enables the preforms to be transferred between several similar cooling devices or between an extraction manipulator and a handling and cooling device, whilst avoiding the need for these devices to perform extensive translations in order

to achieve mutual superimpositions which enable the preforms to be transferred.

In other words, there is a need to provide, within the plants in question, a device for handling and cooling preforms which has a compact structure and which, whilst enabling the preforms to be held and transferred between several similar devices or between an extraction manipulator and a cooling device, does not require large installation and operating spaces.

The problem underlying the present invention is that of devising a device for handling and cooling preforms which has structural and functional characteristics such as to satisfy the above-mentioned needs and at the same time to overcome the disadvantages mentioned with reference to the prior art.

This problem is solved by a preform handling and cooling device, which can cooperate with a holding body that is intended to hold the preforms and is disposed outside a moulding region of a press, the device comprising a manipulator body provided with at least one preform-cooling portion which faces the holding body, and at least one preform-cooling portion which does not face the holding body. The device is characterized in that it further comprises: translation means which can translate the manipulator body alternately between a position of disengagement from the holding body and a position of engagement with that body, the engagement position being suitable for the transfer of the preforms from the holding body to the cooling portion of the manipulator body which faces the holding body, and rotation means which can cause the manipulator body to perform a predefined rotation when it is disengaged from the holding body, in a manner such

that the cooling portion of the manipulator body which is not facing the holding body is turned to face the holding body.

Further characteristics and the advantages of the operating member according to the present invention will become clear from the following description of a preferred but non-limiting embodiment thereof, in which:

Figure 1 is a plan view of a preferred embodiment of a preform-production plant provided with a press, an extraction and cooling manipulator, and handling and cooling devices,

Figure 2 is a side view of the plant of Figure 1,

Figure 3 is a front view of the plant of Figure 1,

Figure 4 is a schematic perspective view of an extraction, handling and cooling unit provided with the extraction manipulator and with the handling and cooling devices of the plant of Figure 1,

Figure 5 is a schematic perspective view of the extraction, handling and cooling unit of Figure 4, supported by a portal structure,

Figure 6 is a lateral section of the extraction and cooling manipulator, provided with support means,

Figure 7 is a section through the extraction and cooling manipulator of Figure 6, in a plan view,

Figure 8 is a side view of a handling and cooling device provided with male elements,

Figure 9 is a section through a male element of the handling and cooling device of Figure 8,

Figure 10 is a side view of the handling and cooling device provided with cavities,

Figure 11 is a view showing a detail of a cavity of the device of Figure 10, in section,

Figures 12a) to 12g) show the sequence for the handling and cooling of a series of preforms, performed in the plant of Figure 1.

In the following description, reference is made to a handling and cooling device incorporated in an embodiment of a preform-production plant.

With reference to the appended drawings, a preform-production plant, generally indicated 1, comprises a press 2 for the injection-moulding of the preforms, an extraction and cooling manipulator 3, a first preform-handling and cooling device 4, a second preform-handling and cooling device 5 (functionally and structurally similar to the first device 4), and a conveyor belt 6 for transporting the preforms towards storage or transportation containers (not shown in the drawing).

The press 2 has a mould 7 provided with a plurality of cavities and a male mould 8 provided with a plurality of male elements, the number and positions of which on the male mould 8 correspond to the number and positions of the cavities in the mould 7.

Moreover, the press 2 has suitable means for moving the male mould 8, which means can bring about a translational movement of the male mould along a moulding line defined by an axis S-S. The plant 1 also has suitable means for moving the extraction and cooling manipulator 3, which means can bring about a translation of the manipulator along an extraction line defined by an axis Z-Z which is substantially perpendicular to the moulding axis S-S.

Finally, the plant 1 comprises means for moving the first and second handling and cooling devices 4 and 5 which means can bring about translation of these devices along a preform-handling line defined by an axis Y-Y, and also rotation of the first and second devices 4 and 5 about respective rotation axes X-X and X'-X'.

The first and second handling and cooling devices 4 and 5 are preferably supported by a portal structure 12 formed by pillars which support horizontal beams on which the devices are suspended. In other words, the first and second devices 4 and 5 are suspended on the portal structure 12 in a "pendulum-like" suitable for allowing the devices to translate and rotate.

At the beginning of the preform-moulding cycle, the female mould 7 and the male mould 8 of the press 2 are in a disengaged configuration in which the movable male mould 8 is in a position spaced from the mould 7. In this configuration, a moulding region 9 extends between the mould 7 and the male mould 8, within the press 2. In this condition, the extraction manipulator 3 is positioned in a cooling region 10 outside the moulding region 9 of the press.

The operation of the means for moving the male mould 8 enables the male mould 8 to be brought into engagement with the mould 7, by means of a translation along the moulding axis S-S. In other words, in the configuration in which the male mould 8 is engaged in the mould 7, the male mould is close to the mould 7 so that the male elements of the male mould penetrate the corresponding cavities of the mould 7. In this configuration, the thermoplastic material is injected into the mould so as to fill the space remaining between a male element of the male mould and the corresponding cavity of the mould in which it is housed.

The moulding cycle terminates with the movement of the male mould 8 away from the mould 7, along the moulding axis S-S. The preforms are retained on the male elements of the male mould 8.

At the start of the extraction stage, the mould 7 and the male mould 8 are in the disengaged configuration with the male mould 8 spaced from the mould 7; the preforms are held on the male elements of the male mould 8 and the extraction and cooling manipulator 3 is in an approach and parking region 9' disposed between the cooling region 10 and the moulding region 9.

The operation of the means for moving the extraction manipulator 3 enables the manipulator to translate from the cooling region 10, firstly to the approach and parking region 9', and then, when the male mould has moved away from the mould, to the moulding region 9, along the extraction axis Z-Z.

In the moulding region 9, the extraction manipulator 3 is in the vicinity of the ends of the male elements of the male mould. In this configuration, the preforms are transferred

from the male mould 8 to the extraction manipulator 3 in the manner described further below.

Further operation of the means for moving the extraction manipulator 3 enables the manipulator to be translated from the moulding region 9 to the cooling region 10, along the extraction axis Z-Z.

Upon completion of the step of the extraction of the preforms from the press 2, the extraction manipulator 3, which holds the preforms, is outside the moulding region 9 and the male mould 8 is free of preforms and is ready to perform a new moulding cycle.

At the start of the preform-handling stage, the first preform cooling and handling device 4 is in a position in which it is disengaged from the extraction manipulator 3 and has a first portion 4' turned to face the extraction manipulator. The first device 4 performs a translation along the handling axis Y-Y, by means of the movement means, and is brought to a position close to the extraction manipulator 3, engaging the manipulator. The preforms are transferred from the extraction manipulator to the portion 4' of the first device 4 which faces the extraction manipulator 3, in the manner and by the means described further below.

The operation of the movement means of the first device enables the first device 4 to be moved away from the extraction manipulator along the handling axis Y-Y, with the preforms held on the first device 4.

The transfer of the preforms to the first device 4 frees the extraction manipulator 3, enabling that manipulator to

perform a new cycle for the extraction of preforms from the male mould 8 of the press 2.

By means of its rotation means, the first device 4 performs a rotation about the rotation axis X-X so that the portion 4'' which is not facing the extraction manipulator 3 is turned to face the manipulator. In this condition, the first device 4 has the portion 4'' which is free of preforms turned towards the extraction manipulator 3.

In other words, in this configuration, the first device 4 has the portion 4'' which is free of preforms turned towards the extraction manipulator 3 and the portion 4' which holds the preforms facing the second device 5.

With a method of operation just the same as that described for the first device 4, the second device 5 approaches the first device 4 by means of a translation along the axis Y-Y. The preforms held by the portion 4' of the first device 4 are transferred to the portion 5' of the second device 5, which portion 5' faces the portion 4' that holds the preforms.

The transfer method and the means used are described in detail in the following part of the description.

The second device 5 moves away from the first device 4 along the axis Y-Y and, in a position of disengagement from the first device 4, performs a rotation about the rotation axis X'-X' so that the portion 5'' of the second device 5 which is not facing the first device 4 is turned to face the first device 4.

In this configuration, the second device 5 has the portion 5'' turned to face the first device 4. At the same time,

the second device 5 has the portion 5', which holds the preforms, turned to face a region 11 outside the plant.

If the portion of the first device 4 which faces the second device 5 is provided with a second series of preforms, the second device 5 which has the portion 5'' facing the first device 4 performs a further translation in order to take the second series of preforms from the first device 4. When the second device 5 is disengaged from the first device 4, it also performs a further rotation about the axis X'-X', turning the portion 5', still provided with the first series of preforms, towards the first device again. The first series of preforms is discharged by means of a device described further below, before the second device 5 performs a further translation in order to pick up a third series of preforms from the first device 4.

The preforms to be discharged are preferably transported on the conveyor belt 6 towards the preform storage or transportation containers.

In the plant described above, each series of preforms performs substantially five cooling cycles.

In other words, each individual series of preforms is handled and cooled by the extraction manipulator 3, by the first device 4, and by the second device 5, for a period of time such that, during the same period, and simultaneously with the handling, the press performs substantially five moulding cycles.

The first handling and cooling device 4 and the second handling and cooling device 5, which are described as incorporated in the preform-production plant 1, form within the plant 1, a preform-handling and cooling unit which can

cooperate with the extraction manipulator 3 in order to cool the preforms adequately before they are discharged.

The first device 4 and the second device 5 constitute individual handling and cooling modules, that is, the first device 4 and the second device 5 represent a first station and a second station of the handling and cooling unit, respectively.

In the plant described, the cooling of the preforms preferably starts in the mould and in the male mould and in the extraction manipulator.

In particular, the cooling of the preforms in the mould and in the male mould can be performed, according to the devices with which the press is provided, by means of forced cooling with water or another coolant fluid. In the water-cooling embodiment, the water temperature is typically between 4 and 20°C and preferably between 8° and 10°C.

The cooling of the preforms preferably continues in the extraction manipulator, by means of liquid cooling devices.

Moreover, the cooling of the preforms continues in the handling devices, substantially in two ways.

In the first place, the contact of the internal surfaces of the preforms with the male elements of the first device 4, or the contact of the outer surfaces of the preforms with the walls of the cavities of the device, brings about a cooling effect owing to conduction of heat from the preforms towards the devices.

Moreover, the cooling is rendered quicker by further cooling means with which the first device 4 and the second device 5

are preferably provided. The forced cooling means are preferably cooling means which make use of the cooling capacity of water or other specific fluids, suitably cooled by known apparatus.

The structure and the operation of these cooling means will be described further below.

Naturally, the presence in the plant of a cooling unit provided with two stations represents purely a preferred embodiment of the plant.

The cooling and handling unit may in fact be formed by a single device, preferably of the type corresponding to the first device 4 which engages the extraction manipulator. In this embodiment, each series of preforms performs substantially three cooling cycles before being discharged.

The cooling unit may also comprise more than two handling and cooling devices, in accordance with a modular structure. By way of example, with the use of a first male device, a second female device, and a third and last male device identical to the first, the preforms would perform seven cooling cycles before being discharged, and would be handled by an alternating sequence of male and female elements.

Functionally, the first handling and cooling device 4 and the second handling and cooling device 5 implement the same principle for handling and cooling the preforms.

Both the first device 4 and the second device 5 can cooperate with a holding device which is intended to hold the preforms and is disposed outside the moulding region 9 of the press 2. The first device 4 cooperates with the extraction manipulator 3, holding the preforms which were

held by the extraction manipulator outside the moulding region 9 of the press 2.

Similarly, the second device 5 cooperates with the first portion of the first device 4 which faces the second device 5 and which forms the device for holding a series of preforms.

Moreover, each of the first and second devices 4 and 5 comprises a manipulator body provided with at least one preform-cooling portion (4' or 5') which faces the holding body and at least one preform-cooling portion (4'' or 5'') which does not face the holding body.

The devices 4 and 5 also comprise translation means which can translate the devices alternately between a position of disengagement from the holding device and a position of engagement with that device, the engagement position being suitable for the transfer of the preforms from the holding body to the cooling portion of the manipulator body facing the holding body.

Finally, the first and second devices 4 and 5 comprise rotation means for causing the devices to perform a predefined rotation so that the cooling portion of the manipulator body that does not face the holding body (portions 4'' or 5'') is turned to face the holding body.

The preforms are removed from the moulding region 9 of the press 2 by means of the extraction manipulator 3 which cooperates with the male mould 8 of the press so that the preforms held on the male elements of the male mould 8 are transferred into corresponding cavities of the extraction manipulator 3.

The extraction manipulator 3 is operatively connected to support means 20.

The support means 20 of the manipulator 3 comprise a track 22 which extends along the extraction axis Z-Z from the cooling region 10 to the approach and parking region 9' in the vicinity of the moulding region 9 in a manner such as not to project into the moulding region, avoiding interference with the movement of the male mould 8.

The track 22 preferably has a box-like structure provided with a sliding surface 22' facing towards the male mould 8 of the press 2.

Moreover, the support means of the extraction manipulator 3 comprise a support arm 24 fixed firmly to the manipulator 3 and preferably having a box-like structure. One end 24' of the support arm 24 is connected to the extraction manipulator 3.

Furthermore, the support means 20 of the manipulator 3 are operatively connected to translation means 26 of the extraction manipulator 3, preferably formed by electrical apparatus such as motors which can move the support arm 24, causing the arm to slide on the sliding surface 22' of the track 22.

The extraction manipulator 3 comprises a substantially parallelepipedal central body 28 connected to the support arm 24 in the region of a connection interface 28'. A free surface 28'' of the central body faces the male mould 8 when the extraction manipulator 3 is in the position of engagement with the male mould 8 of the press 2 and faces the first handling and cooling device 4 of the plant 1 when

the extraction manipulator is in the position of disengagement from the male mould 8.

On its side having the free surface 28'', the central body 28 of the extraction manipulator 3 has a plurality of cavities 30 for receiving and cooling the preforms held by the male mould 8 and for transporting the preforms to the cooling region 10 so as to cooperate with the first handling and cooling device 4.

Each cavity 30 extends about an axis C-C of the cavity within the central body 28. The cavity is put into communication with the outside environment by means of an opening 32 disposed in the free surface 28'' of the central body 28 of the manipulator 3.

The number of openings 32 of the plurality of cavities 30 is equal to the number of male elements of the male mould 8 of the press 2 and the openings 32 are arranged on the free surface 28'' in a manner such that, when the extraction manipulator 3 is in the position of engagement with the male mould 8 of the press 2, each male element of the male mould is positioned in front of the corresponding cavity 30 of the extraction manipulator 3.

Each cavity 30 is defined by an internal wall 34 in which at least three portions can preferably be distinguished.

The internal wall 34 of the cavity 30 comprises a first portion, known as the lead-in wall 36, in the region of the opening 32 of the cavity 30. The lead-in wall 36 preferably extends about the axis C-C of the cavity 30 with a shape which is flared towards the outside of the cavity 30. In other words, the lead-in surface of the cavity 30 has a

substantially frustoconical shape with its larger base facing the opening 32 of the cavity 30.

In a further embodiment, the lead-in wall 36 is formed by a series of at least two frustoconical portions having different inclinations, adjoining one another and having their larger bases facing towards the opening 32 of the cavity.

The internal wall 34 also has a guide wall 38 adjoining the lead-in wall 36 of the cavity 30 and extending towards the interior of the cavity. In a preferred embodiment, the guide wall 38 of the cavity 30 is slightly frustoconical with its larger base facing towards the opening 32 of the cavity 30.

The cavity 30 of the plate 3 is associated with a plurality of cooling passageways 39 which surround it.

In a preferred embodiment, the guide wall 38 of the cavity 30 has the plurality of cooling passageways 39 in the form of spiral channels formed in the guide wall, forming a single helical channel communicating with a coolant-fluid circulation duct 39'.

The circulation duct 39' is fluidodynamically associated with the cooling means of the extraction manipulator 3.

The guide wall 38 of the cavity 30 is closed, towards the interior of the cavity, at the end remote from the opening 32, by a base wall 40, preferably with a hemispherical cap-like configuration.

In a preferred embodiment of the extraction manipulator 3, the base wall 40 of the cavity 30 has at least one suction

passageway 42 which can put the cavity 30 into communication with suction ducts 44.

The suction passageway 42, the suction ducts 44, and suction devices operatively connected with the ducts 44 form preform-gripping means with which the extraction manipulator is provided in order to remove the preforms from the male elements of the male mould 8 and to hold them in the cavities 30.

In order subsequently to disengage the cavities 30 of the extraction manipulator from the preforms and to transfer the preforms to the first handling and cooling device 4, the extraction manipulator 3 further comprises a preform-transfer plate 46 disposed over the free surface 28'' of the central body 28 of the extraction manipulator 3.

The transfer plate 46 has a plurality of through-holes 48 formed in the region of the openings 32 of the cavities 30 so that the transfer plate 46 covers the free surface 28'' of the extraction manipulator 3 only partially.

In other words, the transfer plate 46 renders each cavity 30 accessible from the exterior through the through-holes 48, whilst being arranged over the free surface 28'' in which the openings of the cavities 30 are formed.

The transfer plate 46 is operatively connected to plate-movement means 50 which can move the plate 46 with a translational movement along an axis perpendicular to the free surface 28'' of the extraction manipulator 3. The movement means are operated electrically, hydraulically or pneumatically.

In a preferred embodiment, the movement means of the transfer plate 46 are operated pneumatically and, preferably, are of the "double-acting" type which can move the plate 46 alternately with an outward movement in which the transfer plate moves away from the body of the extraction manipulator 3 to an extended position for the transfer of the preforms from the extraction manipulator 3 to the first device 4 and a return movement to a retracted position upon completion of the transfer of the preforms.

The transfer plate 46 is also operatively connected to safety return means 52 which can return the transfer plate 46 from the extended preform-transfer position to the retracted position. The safety return means 52 can return the transfer plate 46 even if the movement means of the plate 46 are not operating.

In a preferred embodiment, the safety return means 52 are resilient biasing means, preferably springs.

The transfer plate 46, the movement means 50, and the safety return means 52 of the plate 46 represent a preferred embodiment of preform-transfer means with which the extraction manipulator 3 is provided in order to extract the preforms from the central body 28 of the extraction manipulator 3 and to fit them on the preform handling and cooling device.

In a preferred embodiment, the extraction manipulator 3 is made of metal, preferably aluminium alloy.

The extraction manipulator 3 can move, during a first extraction stage, from the cooling region 10 outside the press to the moulding region 9 in the vicinity of the male mould 8, so as to enable the preforms to be transferred from

the male elements of the male mould 8 to the cavities of the extraction manipulator 3, and can return, during a second extraction stage, from the moulding region 9 to the cooling region 10, holding the preforms in the cavities 30.

Upon completion of the second extraction stage, the extraction manipulator 3 faces the first handling and cooling device 4, holds the preforms in the cavities 30, and forms a holding device, housing the preforms.

The first handling and cooling device 4 comprises a manipulator body 60 supported, by means of a support device 62 of the manipulator 60, on a support structure 64, preferably formed by a structure provided with beams supported by lateral pillars.

The manipulator body 60, supported by the support device 62, adopts a pendulum-like configuration. In other words, the support device, which is preferably formed by a substantially vertical member 62' operatively connected to the manipulator body 60, is suspended on the support structure 62, and allows the manipulator body 60 to hang on beams 64 in a manner such that the first handling and cooling device can translate and rotate owing to the action of translation means 66 and rotation means 68.

The translation means 66 and the rotation means 68 are driven by electric, hydraulic or pneumatic means and, preferably, are formed by electric motors.

In a preferred embodiment, the manipulator body 60 is substantially symmetrical with respect to a vertical plane containing the axis of rotation X-X of the manipulator body and is provided, on each symmetrical side, with the first

cooling portion 4' and with the second cooling portion 4'', respectively.

The first and second cooling portions 4' and 4'' can receive the preforms held in the cavities 30 of the extraction manipulator 3 by engaging the preforms on support elements 70 known as male elements.

The male elements 70 of the manipulator body 60 are of a substantially cylindrical shape, extending about respective central axes M-M arranged perpendicular to the surface of the first cooling portion or of the second cooling portion 4' and 4''.

The number of male elements on each cooling portion 4' or 4'' is equal to the number of cavities 30 of the extraction manipulator 3, and the male elements are arranged on the portions in a manner such that, when one of the portions 4' or 4'' of the manipulator body is facing the extraction manipulator 3, each male element 70 is in a position corresponding to that of a respective cavity 30 of the extraction manipulator 3.

In other words, the male elements 70 are arranged on the first and second portions 4' and 4'' in a manner such that, when a portion faces the extraction manipulator 3, the axis M-M of each male element 70 coincides substantially with the axis C-C of each corresponding cavity 30. In order to hold the preforms on the male elements 70 of the manipulator body 60, the first handling and cooling device 4 preferably has preform-retaining means the structure and operation of which will be described in greater detail below.

The first handling and cooling device 4 preferably comprises means for the forced cooling of the preforms, formed by

means for the internal cooling the male elements 70 on which the preforms are fitted, by means of a flow of water or coolant fluids inside the male elements. The structure and the operation of the cooling means is described in greater detail below.

Each male element 70 of the manipulator body 60 comprises an outer portion 72 which projects from the manipulator body 60 and which extends about the central axis M-M, and an attachment collar 74 one end of which can be coupled with the outer portion 72.

The other end of the attachment collar 74, which is not coupled with the outer portion 72, is housed in a seat 76 in the manipulator body 60.

The hollow outer portion 72 of the male element 70 is composed of at least three sections which define its shape. Starting from the free end of the male element 70, a first section 72' of the outer portion 72 has a substantially hemispherical shape and adjoins a second, cylindrical section 72''. The cylindrical section, becoming thicker, adjoins a slightly barrel-shaped base section 72'''.

The base section 72''' has a circumferential groove 78 which houses a resilient retaining ring 80, known as an O-ring.

The ring 80 has an outside diameter such that, when the ring is housed in the groove 78 of the male element 70, the retaining ring projects from the surface of the base section 72''' of the male element 70.

The retaining ring 80 and the groove 78 represent a preferred embodiment of preform-retaining means which can

retain the preforms on the male elements 70 during handling and cooling.

The outer portion 72 of the male element 70 has an axial duct 73 which is closed by the hemispherical section 72' of the outer portion 72.

The outer portion of the male element 70 and the attachment collar 74 are connected to one another by a threaded connection.

The attachment collar 74 is hollow internally, but is shaped externally in a manner such that it can fit in the seat 76 of the manipulator 60 by virtue of a matching shape. The collar 74 also has an end shank 74' at its end which is not engaged by the outer portion 72 of the male element 70.

The collar 74 has an axial through cavity 75 in which two successive portions can be distinguished. At the end which is connected to the outer portion 72 of the male element 70, the axial cavity 75 of the connection collar 74 has a first portion having a diameter larger than the diameter of a second portion remote from the connected end. The portions are cylindrical in shape, extending about the central axis M-M of the male element 70.

The larger-diameter portion of the axial cavity 75 forms an outlet duct 82 and the second portion forms a housing seat 84.

The attachment collar also has a plurality of transverse passageways 86 formed by through-holes in the attachment collar 74 which are in communication with the outlet duct 82 of the collar.

The seat 76 which houses the collar 74 has two successive portions of different diameters. A first portion, which has an opening for the insertion of the collar 74, has a larger diameter than a second, blind portion, in which the end shank 74', of matching shape, of the collar 74 is partially fitted.

The first portion of the seat 76 forms an outlet chamber 76' and the second portion forms an inlet chamber 76'' in the part which is not engaged by the end shank 74' of the collar 74.

Moreover, the inlet chamber 76'' of the seat 76 is in communication with a coolant-fluid inlet duct 89 and the outlet chamber 76' is in communication with a fluid-outlet duct 90.

In the configuration in which the outer portion 72 is mounted on the attachment collar 74 and the collar is in the seat 76, the transverse passageways 86 of the attachment collar communicate with the outlet duct 90 through the outlet chamber 76' of the seat 76.

In this assembled configuration, the inlet duct 89 is in communication with the inlet chamber 76'' of the seat 76 and with the tubular duct 88, forming an inlet path for the coolant fluid extending from the inlet duct 89 to the hemispherical section 72' of the outer portion 72 of the male element 70.

The inlet duct 89 is in communication with apparatus for recirculating and cooling the fluid.

Moreover, in the assembled configuration described, the axial cavity 73 of the outer portion 72 is in communication

with the outlet duct 82 of the collar 74 and, through the transverse passageways 86 of the collar 74, with the outlet duct 90. The axial cavity 73 of the outer portion 72, the outlet duct 82 of the collar 74, the transverse passageways 86 of the collar 74, and the outlet duct 90 form an outlet path for the coolant fluid.

The outlet duct 90, like the inlet duct 89, is operatively connected to apparatus for recirculating and cooling the coolant fluid.

The apparatus for recirculating and cooling the fluid comprises flexible pipes which fluidodynamically connect the inlet and outlet paths of the manipulator body of the first device 4 to the parts of the fluid recirculation and cooling apparatus which are not included in the manipulator body.

The inlet path and the outlet path for the coolant fluid are separated, in the axial duct 73 of the outer portion 72 of the male element 70 and in the axial cavity 75 of the collar 74, by the tubular element 88. In other words, the tubular element 88 allows the cold coolant fluid to flow through it towards the hemispherical section 72' of the male element and, at the same time, is immersed in the hot fluid returning from the section 72' towards the manipulator 60.

The manipulator body 60 is made of metal, preferably aluminium alloy.

The first handling and cooling device 4 can cooperate with the extraction manipulator 3 of the preform-production plant to enable the preforms housed in the cavities 30 of the extraction manipulator 3 to be transferred to the male elements 70 of the first cooling portion 4' which faces the extraction manipulator 3.

The rotation means 68 enable the manipulator body 60 of the first device 4 to perform a predefined rotation in a manner such that the second cooling portion 4'' which is not facing the extraction manipulator 3 is turned to face the extraction manipulator and, at the same time, the first portion 4', which has the male elements 70 on which the preforms are fitted, is turned to face the second handling and cooling device 5.

In the above-mentioned conditions, the first handling and cooling device 4 holds the preforms on the male elements 70 and forms a holding device which holds the preforms.

The operation of the second device 5 is similar to the operation of the first device 4. However, the second device 5 which takes the preforms from the first device 4 has preform-retaining elements suitable for holding the preforms by taking them from the male elements 70 of the manipulator 60 of the first device 4.

The second handling and cooling device 5 comprises a manipulator body 100 which is supported on the portal support structure by means of a support device 102. The manipulator 100 adopts a pendulum-like configuration on the portion structure. Translation means 104 and rotation means 106, preferably of the electrical type, enable the manipulator 100 to translate and rotate.

The manipulator 100 is preferably substantially symmetrical with respect to a vertical plane which contains the axis of rotation X'-X' of the manipulator 100 and has, on each symmetrical portion, a first cooling portion 5' and a second cooling portion 5'', respectively.

The first and second cooling portions can receive the preforms fitted on the male elements 70 of the manipulator 60 of the first device 4, housing the preforms in a plurality of cavities 108.

The cavities 108 are wholly similar, functionally and structurally, to the cavities 30 provided in the extraction manipulator 3.

Each cavity 108 of the manipulator 100 extends about a central axis C-C arranged perpendicular to the surface of the first or second cooling portion 5' or 5''. On each cooling portion 5' or 5'', the number of cavities 108 is equal to the number of male elements 70 of the manipulator 60 and the cavities are arranged on the portions in a manner such that, when one of the portions is facing the manipulator body 60, the axis C-C of each cavity 108 coincides with the axis M-M of each male element 70 of the manipulator 60.

In a preferred embodiment of the second handling and cooling device 5, the device comprises preform-gripping means which can transfer the preforms from the male elements 70 of the manipulator 60 to the cavities 108 of the manipulator 100.

The preform-gripping means preferably comprise air-suction passageways 114 operatively connected to the cavities 108 of the manipulator and to suction means of known type, not described.

The suction means can produce a partial vacuum in the cavities 108 which, when a cavity 108 is engaged on the corresponding male element 70 on which the preform is fitted, cooperates to transfer the preform from the male element 70 to the cavity 108.

Structurally, the gripping means of the second device 5 are just the same as the gripping means of the extraction manipulator 3 described in detail above.

In a preferred embodiment, the second handling and cooling device 5 comprises means for the forced cooling of the cavities 108.

The cooling means have cooling passageways 116 and circulation ducts 118 just the same, structurally and functionally, as the cooling passageways 39 and the circulation ducts 39' of the extraction manipulator 3, as described above.

In a further embodiment, the second device 5 comprises preform-transfer means which can disengage the preforms from the second device 5, extracting them from the cavities 108 in which they are housed.

In particular, the transfer means comprise a movable transfer plate 120 which is provided with through holes 122 and means for moving the plate and is structurally just the same as the transfer plate 46 of the extraction manipulator 3.

The transfer means of the second device 5 can transfer the preforms towards further downstream handling and cooling devices (preferably of the type corresponding to the first device 4) after a predefined rotation of the manipulator 100.

The transfer means can also extract the preforms from the cavities to enable them to be removed from the manipulator and to be transported on the conveyor belt.

The manipulator body of the second device 5 is made of metal, preferably aluminium alloy.

In a preferred embodiment, the second handling and cooling device 5 also comprises a preform-ejection system, known as a "bar" ejection system.

The "bar" ejection system comprises an ejection plate 110 fixed firmly to a bar element 112. The bar element is positioned in the vicinity of the hemispherical end section 72'' of the preform when the preform is housed in the cavity 109 of the second device 5.

The description of the operation of the plant 1 provided with the handling and cooling unit comprising the extraction manipulator 3, the first device 4 and the second device 5 is given below, describing in detail the ways in which the gripping means of the extraction manipulator 3, the retaining and transfer means of the first device 4, and the gripping and transfer means 7 of the second device 5 operate and cooperate with one another.

The preform-moulding cycle terminates with the movement of the male mould 8 away from the mould 7 of the press. The preforms are held on the male elements of the male mould 8. In this configuration, the extraction manipulator 3 is in the cooling region 10, outside and adjacent the moulding region 9.

The movement means of the extraction manipulator 3 bring the manipulator into the approach and parking region 9'. The extraction manipulator 3 stops in the region 9' until the male mould 8 is completely disengaged from the mould 7. The manipulator 3 is then brought into the moulding region 9 to

a position suitable for cooperating with the male mould 8 of the press.

In particular, the translation means 26 of the extraction manipulator 3 enable the support arm 24 to slide on the track 22 until it projects from the track, adopting a cantilevered configuration.

The end of the support arm 24 which is in the vicinity of the moulding region 9 is firmly fixed to the extraction manipulator 3. The cantilevered configuration of the arm 24 relative to the track 22 enables the extraction manipulator 3 to face the male mould 8 of the press. In other words, in this configuration, each male element of the male mould 8 faces a corresponding cavity 30 of the extraction manipulator 3.

The operation of the suction means operatively connected to the extraction manipulator 3 produces a partial vacuum in the suction ducts 44 and in the suction passageways 42 of the central body 28 of the manipulator 3.

In each cavity 30 of the extraction manipulator, the partial vacuum generates a suction force which can act on the preform fitted on the male element facing the cavity 30, cooperating to pull the preform off the male element. The preform is thus drawn towards the cavity and is partially housed therein.

In the embodiment of the extraction manipulator 3 which provides for the transfer plate 46, the preform passes into the cavity 30 through the through-hole 48 of the plate 46 corresponding to the cavity 30.

A residual portion of the preform P which remains outside the cavity 30 of the extraction manipulator 30 has an annular projection P' which is formed in the course of the moulding. In this configuration, the annular projection P' of the preform P also remains outside the transfer plate 46 of the extraction manipulator 3 and cannot pass beyond the corresponding through-hole 48 since it has dimensions larger than the hole.

The suction means of the gripping means of the extraction manipulator operate continuously over time, producing a continuous force drawing the preform towards the interior of the cavity 30.

The contact of the preform with the internal wall 34 of the cavity 30 in itself brings about cooling of the preform owing to the intimate contact between the inner wall 34 and the preform.

Moreover, the action of the cooling means of the extraction manipulator cools the internal wall 34 of the cavity 30 which is in contact with the preform.

The cooling of the preforms inevitably results in a shrinkage of the preform and in a tendency of the preform to come away from the internal wall 34 of the cavity 30.

The continuous action of the suction means of the extraction manipulator 3 and the slightly frustoconical shape of the guide wall 38 of the inner wall 34 of the cavity 30, however, enable the preform to be drawn towards the interior of the cavity 30, ensuring intimate contact between the preform and the internal wall 34 of the cavity 30 in the various conditions of cooling of the preform.

When the preforms are housed in the cavities 30, the extraction manipulator 3 returns to the cooling region 10. In this configuration, the support arm 24 is held on the track 22. The track does not project into the moulding region 9 of the press 2, so that moulding cycles can be performed without interference between the movable male mould 8 and the track 22 of the extraction manipulator.

In this configuration, the cooling and handling device 4 is in a position in which it is disengaged from the extraction manipulator and has its first cooling portion 4' facing the plate.

The operation of the translation means of the first device 4 enables the device to be brought, by means of a translation, to a position of engagement with the extraction manipulator 3.

In particular, in the position of engagement with the manipulator 3, the hemispherical section 72' of each male element 70 of the facing portion 4' of the first device 4 is in the vicinity of the through-hole 48 of the transfer plate 46 corresponding to the opening 32 of the cavity 30.

The transfer plate 46 performs a translation in a direction perpendicular to the surface of the central body 28 of the extraction manipulator. The movement of the plate 46 interferes with the annular projection P' of the preform P housed in the cavity 30, pulling the preform out of the cavity 30 of the extraction manipulator 3.

The travel of the transfer plate 46 is such that the preform is fitted onto the corresponding male element 70 of the first device 4.

Moreover, in the embodiment of the manipulator 60 of the first device 4 which provides for means for retaining the preform on the male element, the travel of the transfer plate 46 is such that the preform fitted on the male element 70 achieves an interference coupling with the male element 70 by means of the portion of the retaining ring 80 that projects from the channel 78 in which the ring is housed.

In other words, the inside diameter of the preform, in the cooling conditions reached on the extraction manipulator, is slightly less than the outside diameter of the retaining ring 80 housed in the groove 78. When the preform is fitted on the corresponding male element 70, interference thus takes place between the preform and the male element and can hold the preform on the male element.

The transfer plate 46 is returned from the extended, preform-transfer position to the retracted position by the double-acting translation means.

The first cooling and handling device 4 moves away from the position of engagement with the extraction manipulator 3 by means of a return translation, returning to a position in which it is disengaged from the extraction manipulator.

The rotation means 68 of the first device 4 bring about a predefined rotation of the manipulator body 60 of the first device 4 so that the second cooling portion 4'' which is not facing the extraction manipulator is turned to face the extraction manipulator.

In a preferred embodiment, the first handling and cooling device 4 comprises two opposed cooling portions 4' and 4'' of which the former faces the extraction manipulator 3 and the latter does not face it. A predefined rotation through

180° consequently enables the first cooling portion 4'' which is not facing the extraction manipulator 3 to be turned to face it.

The first cooling portion 4' which carries the preforms thus becomes the cooling portion which is not facing the extraction manipulator 3 but which faces the second handling and cooling device 5.

The rotation which enables the first cooling portion 4'' to face the extraction manipulator is performed clockwise or anticlockwise about the rotation axis X-X. In either case, during the next operating cycle of the first device 4, the rotation which will turn the first portion 4' to face the extraction manipulator again and will turn the second portion 4'' away from the extraction manipulator 3 is performed in the opposite direction to that of the previous rotation, that is, anticlockwise or clockwise, respectively.

In other words, in the embodiment with two opposed cooling portions 4' and 4'', the first device 4 performs rotations through 180° in the course of successive operating cycles in a manner such as in any case not to perform a complete rotation about the rotation axis X-X since a clockwise rotation is followed by an anticlockwise rotation, or *vice versa*.

From the transfer from the extraction manipulator 3 to the first device 4 until the transfer from the first device 4 to the second device 5, the preform remains internally in contact with the surface of the outer portion 72 of the male element 70, bringing about internal cooling of the preform owing to intimate contact of the internal surface of the preform with the male element 70.

Moreover, the internal cooling of the preform is forced by the cooling means with which the first device 4 is provided.

In particular, a cold coolant fluid such as water or the like, coming from the cooling device, passes through the inlet duct 89 and the inlet chamber 76'' of the seat 76 of the male element 70, and the tubular element 88 as far as the hemispherical section 72' of the male element 70.

The fluid then passes through the axial cavity 75 of the male element 70, the outlet duct 82 of the attachment collar 74, and the transverse passageways 86 until it flows out into apparatus for cooling and recirculating the coolant fluid.

The coolant fluid flows through the hemispherical section 72' of the male element 70 with turbulence phenomena which are accentuated by the particular shape of the end section of the tubular element 88 and also passes over the internal surface of the cylindrical section 72'' and of the base section 72''' of the male element 70.

The forced cooling of the preforms also continues in the second handling and cooling device 5 which is provided with cooling means structurally and functionally just the same as the cooling means of the extraction manipulator 3.

In particular, from the point of view of the cooling, the extraction manipulator 3, the first device 4, and the second device 5 represent independent cooling stations.

In other words, by suitably regulating the cooling device of the extraction manipulator 3, of the first device 4, or of the second device 5, it is possible to achieve three different conditions of cooling of the preforms in the three

stations by controlling the temperature of the coolant fluid independently in the three stations.

In exactly the same manner as described for the translation of the first device 4, the second device 5 performs a translation which brings it into engagement with the first device 4 in a manner such that the openings of the cavities 108 of the second device 5 are in the vicinity of the hemispherical portions of the male elements 70 of the portion 4' which is holding the preforms.

The gripping means of the cooling and handling device 5 enable the preforms to be transferred from the male elements 70 of the first device 4 to the cavities 108 of the second device in exactly the same way as described for the gripping means of the extraction manipulator 3.

When a predefined rotation about the rotation axis X'-X' has been performed, the manipulator 100 of the second device 5 has the first portion 5' which houses the preforms turned towards the region 11 outside the plant, whilst the second cooling portion 5'' faces the first device 4.

The gripping means of the second device 5 can release the preforms from the cavities 108 in order for the preforms to be transferred, preferably by dropping, towards the conveyor belt or to be transferred to further cooling stations (preferably similar to the first device 4).

The operation to eject the preform from the cavity takes place, in a preferred embodiment, by combined operation of the "plate" system and of the "bar" system. In particular, the forward movement of the transfer plate 46 of the second device 5 partially extracts the preform from the cavity 108. The ejection plate 110 of the "bar" system moves forward

simultaneously with the transfer plate of the second device 5.

When the transfer plate 46 has reached its travel limit, it performs a return movement, whilst the ejection plate continues its forward movement until the preform drops onto the conveyor belt.

In other words, when the transfer plate has reached its travel limit, it is retracted, leaving a larger portion of the preform exposed and the ejection plate 110 moves forward until the bar element 112, by pushing the preform, causes the centre of gravity of the preform to be disposed outside the cavity 108, causing the preform to drop.

Unusually, in the field of preform-production plants, the preform handling and cooling device has a particularly compact structure which, whilst enabling the preforms to be held and transferred between several cooling devices, does not require large installation and operation spaces.

In other words, the handling and cooling device enables the preforms to be transferred between several handling and cooling devices or between an extraction manipulator and a handling and cooling device, whilst avoiding the need for these devices to perform extensive translational movements in order to bring about mutual superimpositions which permit the transfer of the preforms.

Advantageously, a single handling and cooling device or a cooling unit provided with several similar devices, together with a manipulator for the extraction of the preforms from the press, can be installed in association with already existing presses in order to provide a new plant which

permits adequate cooling of the preforms before they are discharged.

The provision of a plant in which the cooling unit is associated with an already existing press is facilitated since it is necessary to provide only one compact portal structure which is arranged beside the press and can support the cooling unit.

Moreover, the handling and cooling device has the advantage that it can provide cooling units which contain several devices in series, in a modular arrangement, to provide a plant which holds and cools the preforms for a desired number of cooling cycles.

Clearly, the series of devices must perform a sequence of transfers of the preforms from a male element to a cavity and from a cavity to a male element.

Advantageously, a sequence of transfers of the preforms from male elements to cavities or from cavities to male elements enables the preforms to be cooled adequately both externally and internally. In particular, the ability to cool the preform externally and internally has the advantage of preventing deformation of the preform or the creation of residual tensions therein due to non-homogeneous cooling, for example, excessive cooling on the outside and zero cooling on the inside (cooling in a cavity) or excessive cooling on the inside and no significant cooling on the outside (cooling on a male element).

Moreover, the handling and cooling device permits the provision of units having several devices, enabling the preform to be cooled for a large number of cooling cycles. By way of example, with the use of an extraction manipulator

and a male manipulator, it is possible to perform three cooling cycles on the preforms before they are discharged. In another example, a unit provided with two devices (male elements and cavities) combined with an extraction manipulator, enables five cooling cycles to be performed.

Advantageously, in a cooling unit comprising an extraction manipulator and a handling and cooling device, it is possible to regulate the cooling conditions independently in the manipulator 3 and in the first device 4 by independent control of the coolant-fluid temperature.

Moreover, the device has the advantage of enabling the preforms to be discharged, after a number of cooling cycles, at a final temperature which is low enough to prevent adhesion between preforms collected in storage or transportation containers. Advantageously, the particularly low final temperature is reached without increasing the cycle time of the press, leaving the production rate unchanged.

Moreover, the handling and cooling device has low inertia with respect to translation and low inertia with respect to rotation, which is further reduced by the rotation of the device about an axis of rotation which coincides with the central axis of inertia of the device.

Furthermore, in a preferred embodiment, the manipulator body of the handling and cooling device rotates clockwise and anticlockwise alternately and does not perform a complete rotation about its rotation axis. The flexible pipes for fluidodynamic connection between the manipulator body and the exterior are therefore advantageously not twisted around the manipulator body.

Finally, in the embodiment with a frustoconical cavity for housing the preforms, the manipulation and cooling device has the advantage that the preform is drawn towards the interior of the cavity, ensuring intimate contact of the walls of the preform with the internal surface of the cavity, facilitating heat exchange and hence cooling.

Naturally, in order to satisfy contingent and specific requirements, an expert in the art may apply to the preform handling and cooling device described many modifications and variations all of which, however, are included within the scope of protection of the invention as defined by the appended claims.

## CLAIMS

1. Preform handling and cooling device (4, 5), which can cooperate with a holding device (3, 4) that is intended to hold the preforms and is disposed outside a moulding region (9) of a press (2), the handling and cooling device comprising:

a manipulator body (60, 100) provided with at least one preform-cooling portion (4', 5') which faces the holding body (3, 4), and

at least one preform-cooling portion (4'', 5'') which does not face the holding body (3, 4),

characterized in that the device further comprises:

- translation means (66, 106) suitable for translating the manipulator body (60, 100) alternately between a position of disengagement from the holding body (3, 4) and a position of engagement with that body, the engagement position being suitable for the transfer of the preforms from the holding body (3, 4) to the cooling portion (4', 5') of the manipulator body (60, 100) which faces the holding body (3, 4), and

- rotation means (68, 108) suitable for causing the manipulator body (60, 100) to perform a predefined rotation when it is disengaged from the holding body (3, 4) in a manner such that the cooling portion (4'', 5'') of the manipulator body (60, 100) which is not facing the holding body (3, 4) is turned to face the holding body.

2. Device according to Claim 1 in which the rotating means (68, 108) cause the manipulator body (60, 100) to perform a

rotation in a clockwise direction and in an anticlockwise direction, alternately.

3. Device according to Claim 1 or Claim 2 in which the cooling portion (4', 5') of the manipulator body (60, 100) which faces the holding device (3, 4) and the cooling portion (4'', 5'') of the manipulator body (60, 100) which does not face the holding device (3, 4) comprise support elements suitable for holding the preforms.

4. Device according to Claim 3, further comprising means for the forced cooling of the preform-support elements, associated with said preform-support eleemnts.

5. Device according to Claim 4 in which the forced cooling means are cooling means with circulation of coolant fluid.

6. Device according to Claim 5 in which the coolant fluid is water.

7. Device according to Claim 3 in which the preform-support elements are elongate elements known as male elements (70) projecting from the surface of the cooling portion (4') of the manipulator body (60) which faces the holding device (3) and from the cooling portion (4'') of the manipulator body (60) which does not face the holding device (3).

8. Device according to Claim 7 further comprising means for the forced cooling of the preforms, associated with each male element (70).

9. Device according to Claim 7 in which each male element has an internal cavity (73).

10. Device according to Claim 9 further comprising means, associated with each male element (70), for the forced cooling of the preforms, the means providing for a flow of coolant fluid in the cavity (73) of each male element (70).

11. Device according to Claim 7 further comprising preform-retaining means associated with each male element (70), suitable for retaining the preforms on the male element (70).

12. Device according to Claim 11 in which the means for retaining the preforms on the male element comprise a circumferential groove (78) formed on the male element (70) and a resilient retaining ring (80) fitted in the groove (78) in a manner such that a peripheral portion of the ring projects from the groove (78) of the male element.

13. Device according to Claim 3 in which the preform-support elements are cavities (108) that are formed in the cooling portion (5') of the manipulator body (100) which faces the holding device and in the cooling portion (5'') of the manipulator body (100) which does not face the holding device, suitable for containing the preforms.

14. Device according to Claim 13 in which each cavity (108) is partially delimited by a frustoconical guide wall.

15. Device according to Claim 13 further comprising preform-gripping means for transferring the preforms from the holding device to the cavities (108) of the manipulator body (100).

16. Device according to Claim 15 in which the gripping means comprise suction passageways (114) which put the cavities (108) into communication with suction ducts connected to

suction apparatus, the suction apparatus being able to create, in the cavities (108), a partial vacuum which can draw the preform into the cavity.

17. Device according to Claim 13 further comprising means for the forced cooling of the preforms housed in the cavities (108), the means being associated with each cavity (108) and providing a flow of coolant fluid around each cavity (108) of the manipulator (100).

18. Device according to Claim 17 in which the cooling means comprise a cooling passageway (116) which extends continuously around the cavity (108) and communicates with coolant-fluid circulation ducts (118) connected to coolant-fluid recirculation devices.

19. Device according to Claim 13 further comprising preform-transfer means which can disengage the preforms from the cavities (108) of the manipulator (100) and transfer them to a further holding device.

20. Device according to Claim 19 in which the preform-transfer means comprise a movable transfer plate (120) and means for translating the plate.

21. Device according to Claim 20 in which the transfer plate (120) partially covers the surface of the respective cooling portion (5', 5'') of the manipulator body (100).

22. Device according to Claim 21 in which the transfer plate (120) comprises through holes (122) which are arranged in positions corresponding to those of respective cavities (108) of the manipulator body (100) and which can afford access to the cavities, for the preforms, through the transfer plate (120).

23. Device according to Claim 1 in which the manipulator body is made of metal.

24. Device according to Claim 23 in which the manipulator body is made of aluminium alloy.

25. Device according to Claim 1 in which the translation means (66, 106) comprise electrically-operated motors.

26. Device according to Claim 1 in which the rotation means (68, 108) comprise electrically-operated motors.

27. Device according to Claim 1, further comprising means for supporting the device, comprising a portal structure (12) which can support the device in a "pendulum-like" configuration.

28. Preform-handling and cooling unit which can be associated with an extraction manipulator (3) for extracting the preforms from a moulding region (9) of a press (2) and transferring the preforms to a cooling region (10) outside the moulding region (9), the unit comprising:

- a male handling and cooling device (4) according to any one of Claims 7 to 12, and

- a female handling and cooling device (5) according to any one of Claims 13 to 22.

29. Handling and cooling unit according to Claim 28 in which the means for the forced cooling of the male handling and cooling device (4) and the means for the forced cooling of the female handling and cooling device (5) have independent regulation of the cooling conditions.

30. Handling and cooling unit according to Claim 28, further comprising support means for the unit, comprising a portal structure (12) which can support the male device (4) and the female device (5) in a "pendulum-like" configuration.

31. Extraction, handling and cooling unit, comprising:

- an extraction and cooling manipulator (3) provided with cavities (30) for housing the preforms, preform-gripping means which can remove the preforms from male elements of a male mould (8) of a press (2) and draw them into the cavities (30) of the extraction manipulator (3),

- translation means for translating the manipulator (3) alternately between a position of disengagement from the press (2) and a position of engagement with the press, the engagement position being suitable for the transfer of the preforms from the press (2) to the extraction manipulator (3), and

a male handling and cooling device (4) according to any one of Claims 7 to 12.

32. Extraction, handling and cooling unit according to Claim 31 in which each cavity (39) of the extraction manipulator (3) is partially delimited by a frustoconical guide wall (38).

33. Extraction, handling and cooling unit according to Claim 31 in which the gripping means comprise suction passageways (42) which put the cavities (30) into communication with suction ducts (44) connected to suction apparatus, the suction apparatus being able to create, in the cavities

(30), a partial vacuum which can draw the preform into the cavity (30).

34. Extraction, handling and cooling unit according to Claim 31, further comprising means for the forced cooling of the preforms housed in the cavities (30), the means being associated with each cavity and providing a flow of coolant fluid around each cavity of the extraction manipulator (3).

35. Extraction, manipulation and cooling unit according to Claim 34 in which the means for the forced cooling of the cavities (30) of the extraction manipulator (3) and the means for the forced cooling of the male handling and cooling device (4) have independent regulation of the cooling conditions.

36. Extraction, handling and cooling unit according to Claim 34 in which the cooling means comprise cooling passageways (39) around the cavity (30), communicating with coolant-fluid circulation ducts (39') connected to coolant-fluid cooling and recirculation apparatus.

37. Extraction, handling and cooling unit according to Claim 31, further comprising preform-transfer means which can disengage the preforms from the cavities (30) of the extraction manipulator (3) and transfer them to the male handling and cooling device (4).

38. Extraction, handling and cooling unit according to Claim 37 in which the preform-transfer means comprise a movable transfer plate (46) and means for translating the plate.

39. Extraction, handling and cooling unit according to Claim 38 in which the transfer plate (46) partially covers the surface of the extraction manipulator (3).

40. Extraction, handling and cooling unit according to Claim 39 in which the transfer plate (46) comprises through-holes (48) which are arranged in positions corresponding to those of respective cavities (30) of the extraction manipulator (3) and which can afford access to the cavities (30), for the preforms, through the transfer plate (46).

41. Extraction, handling and cooling unit according to any one of Claims 31 to 40, further comprising support means for the unit, comprising a portal structure (12) which is firmly fixed to support means of the extraction manipulator (3) and can support the male handling and cooling device (4) in a "pendulum-like" configuration.

42. Extraction, manipulation and cooling unit according to any one of Claims 31 to 41, further comprising a female handling and cooling device (5) according to any one of Claims 13 to 22.

43. Method of handling and cooling preforms, comprising the steps of:

- translating a preform handling and cooling device (4, 5) from a position of disengagement from a preform-holding device (3, 4) to a position of engagement with the holding device, the handling device being able to cooperate with the holding device in the engagement position,

- transferring a plurality of preforms held in the holding device (3, 4) to a first cooling portion (4', 5') of the handling and cooling device (4, 5), the first cooling portion (4', 5') being arranged facing the holding device (3, 4),

- translating the handling and cooling device (4, 5) to the disengagement position, and

- rotating the handling and cooling device (4, 5), so that a second cooling portion (4'', 5'') of the handling and cooling device (4, 5) faces the holding device (3, 4).

44. Method according to Claim 43, further comprising the steps of:

- forcibly and continuously cooling the preforms on the handling and cooling device (4, 5).

45. Method according to Claim 43 or Claim 44 in which the steps of rotating the handling and cooling device (4, 5) take place in a clockwise direction and in an anticlockwise direction, alternately.

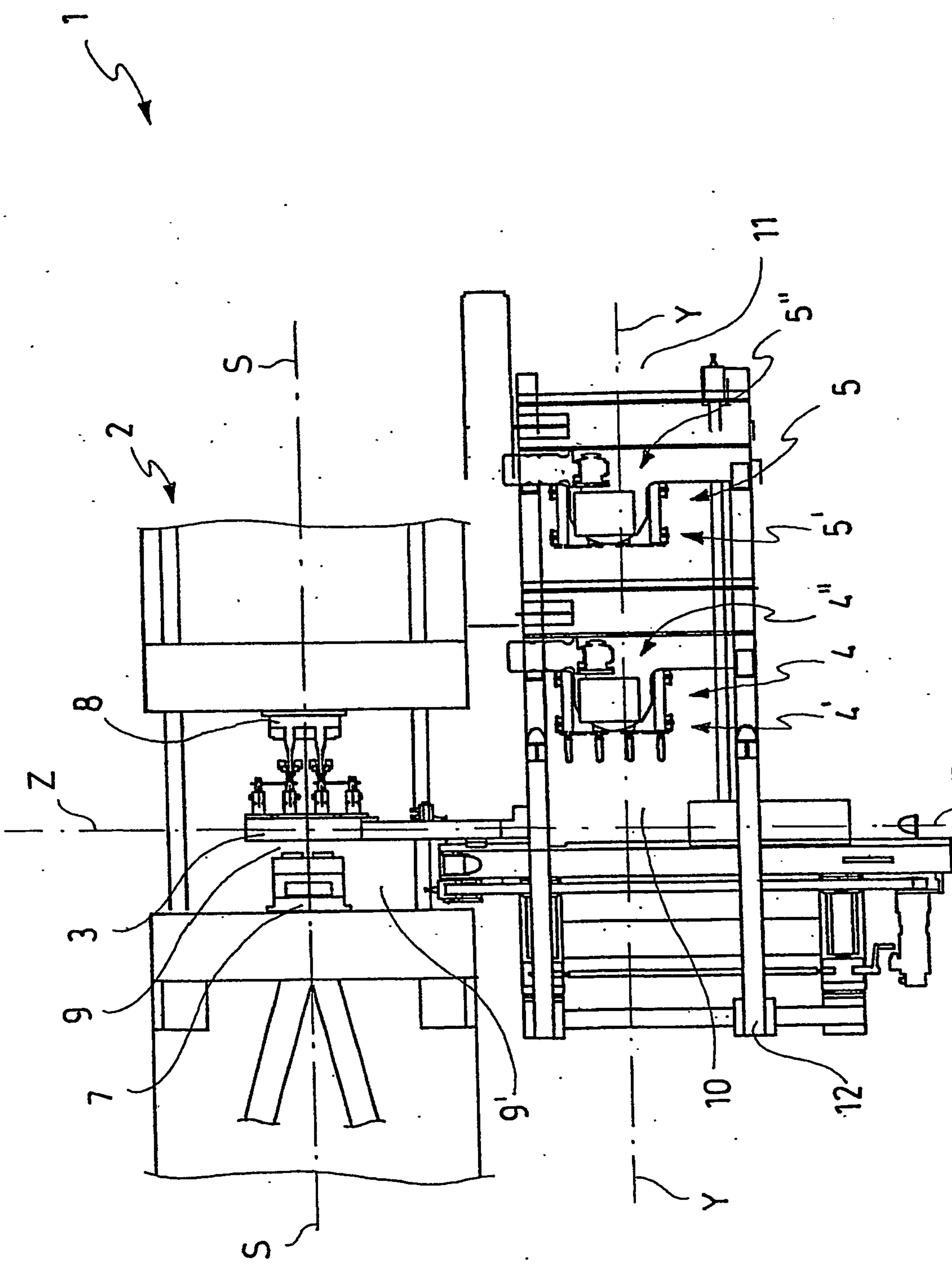


FIG.1

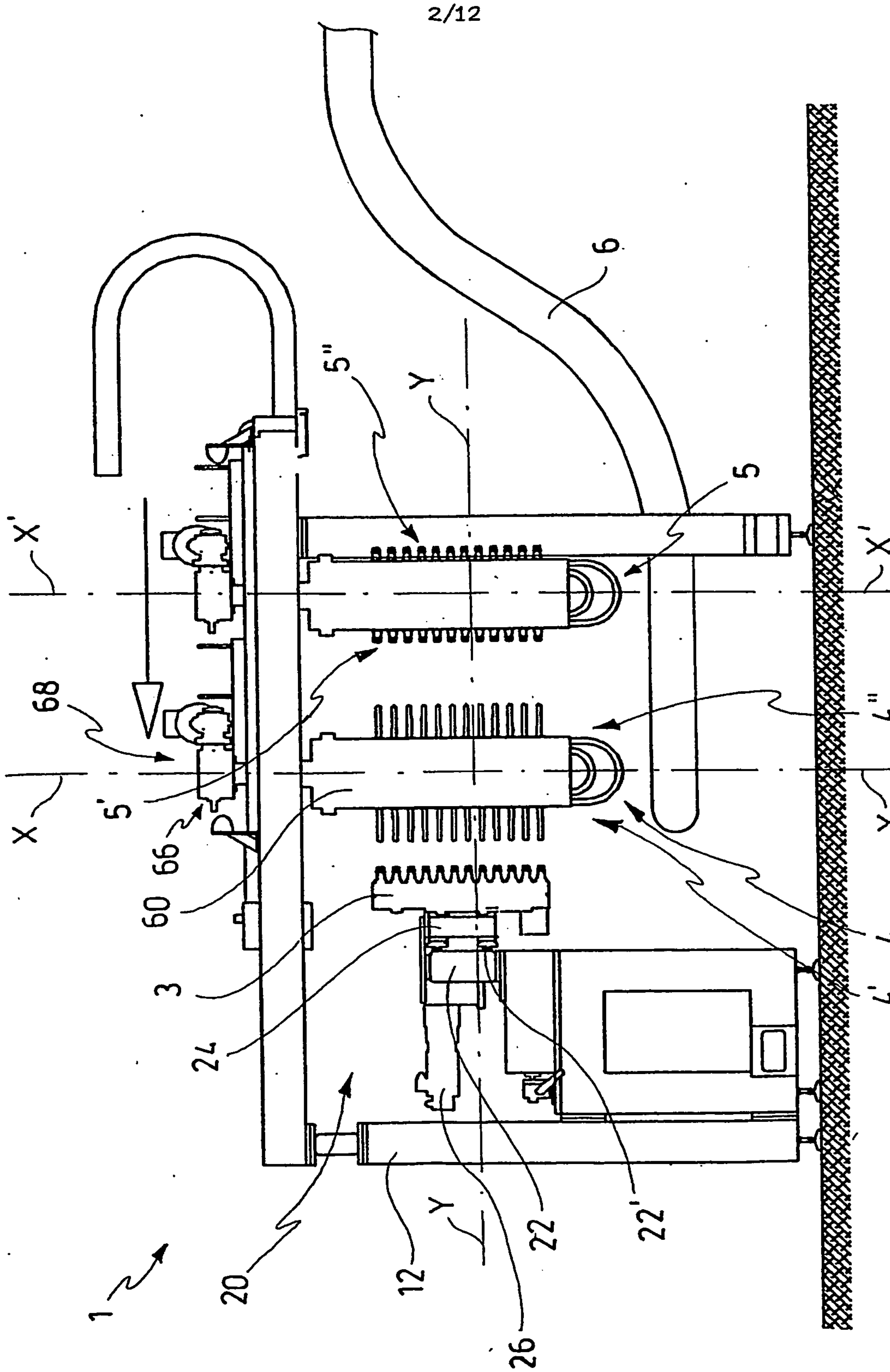


FIG.2

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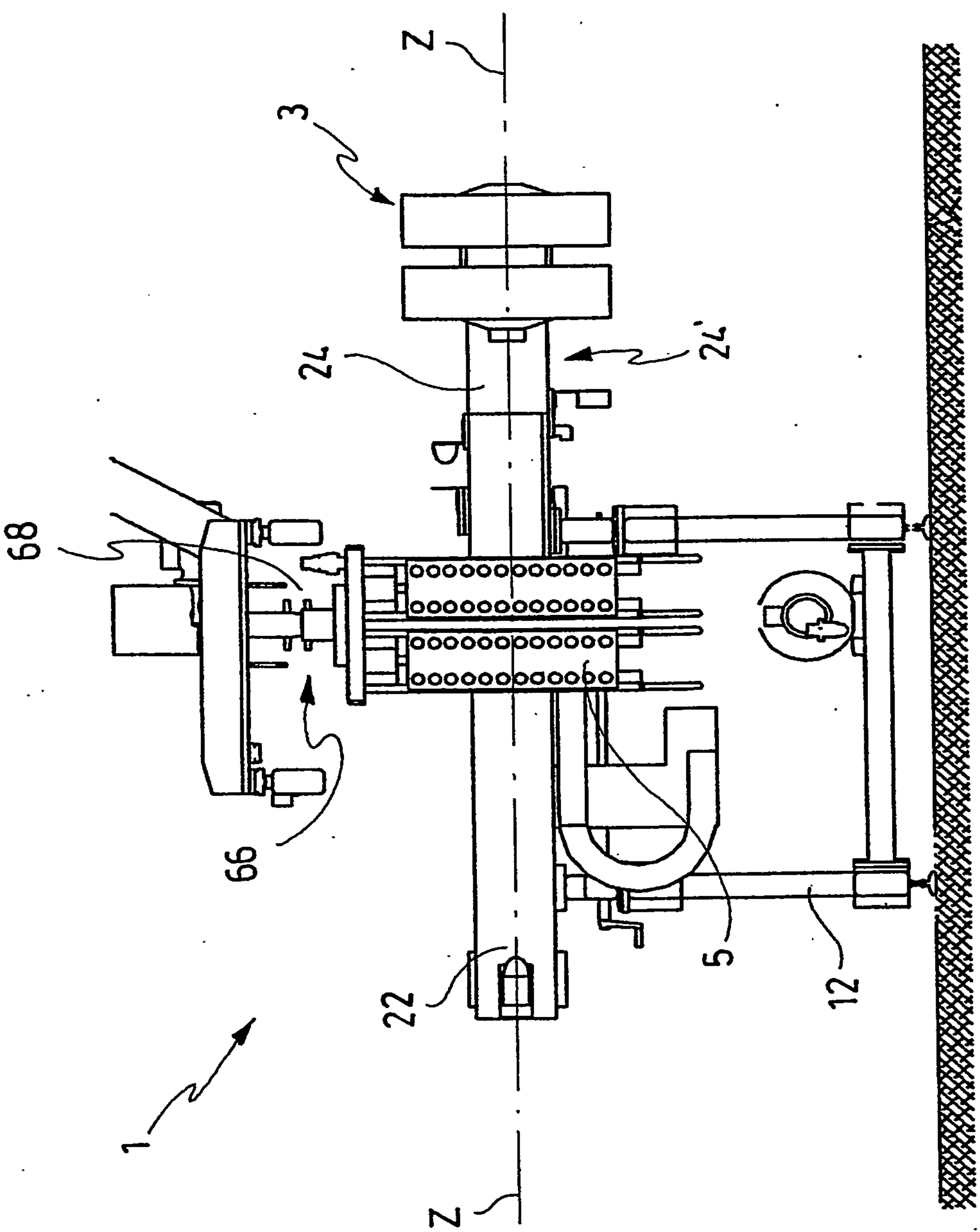



FIG. 3

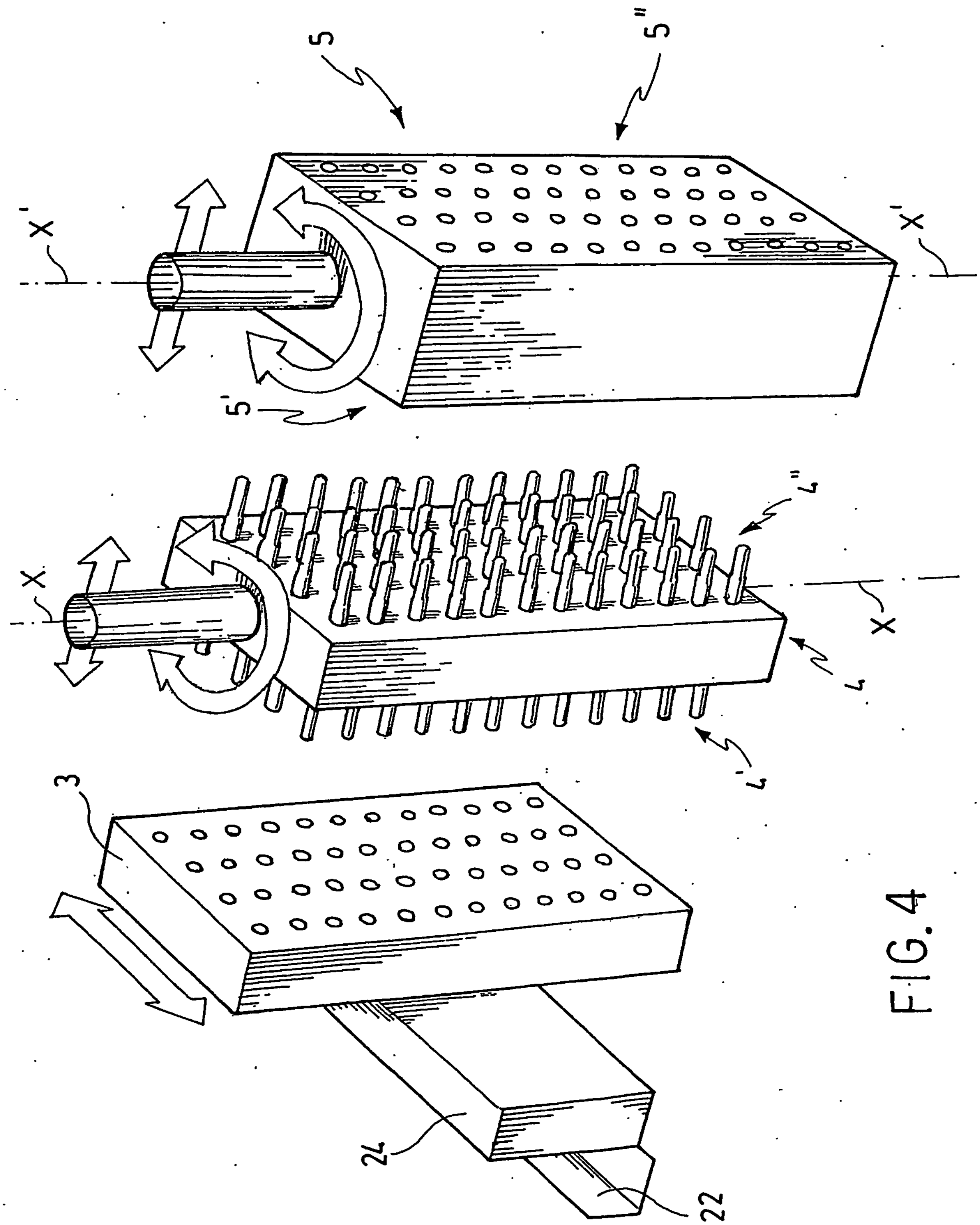



FIG.4

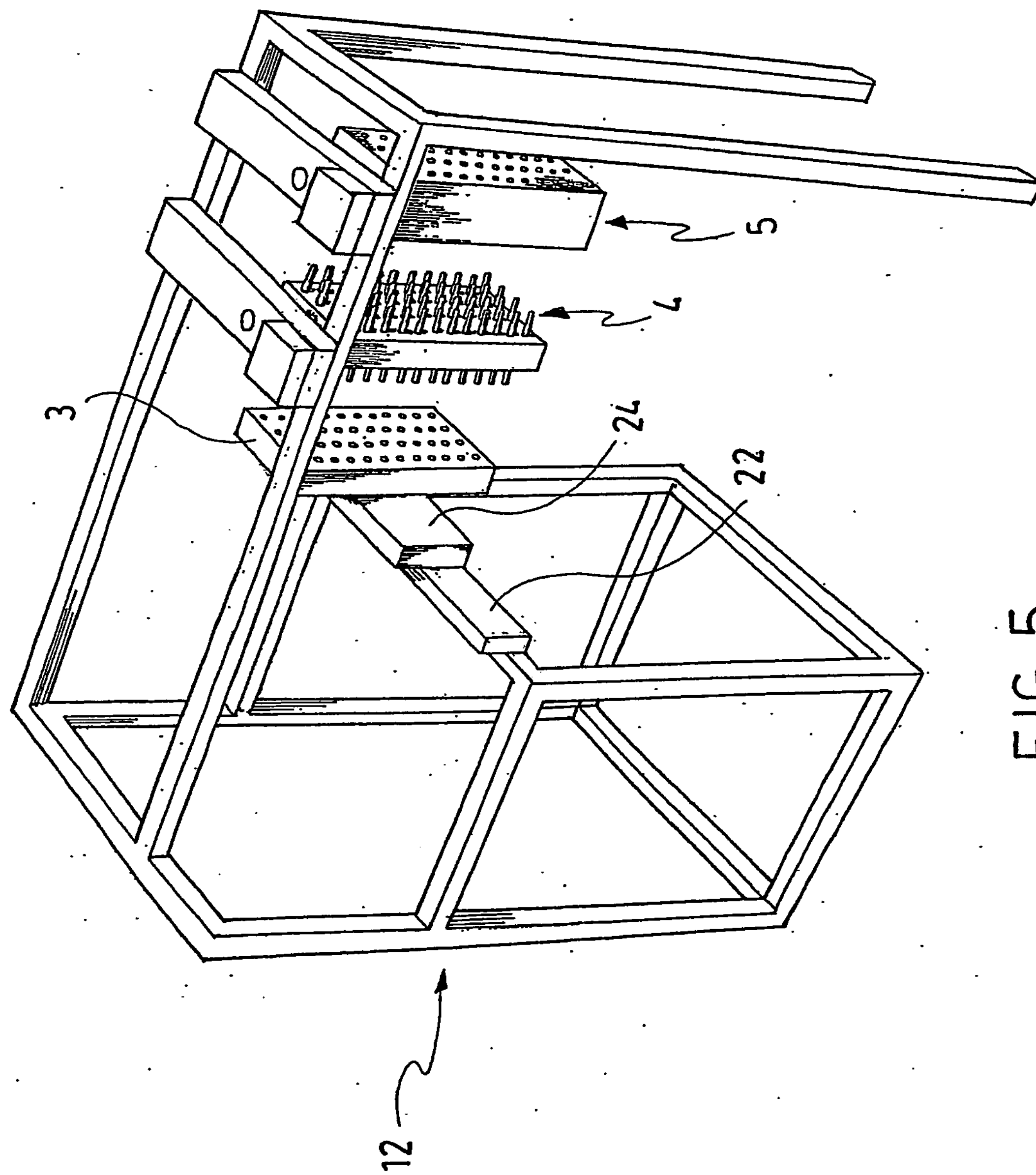



FIG. 5

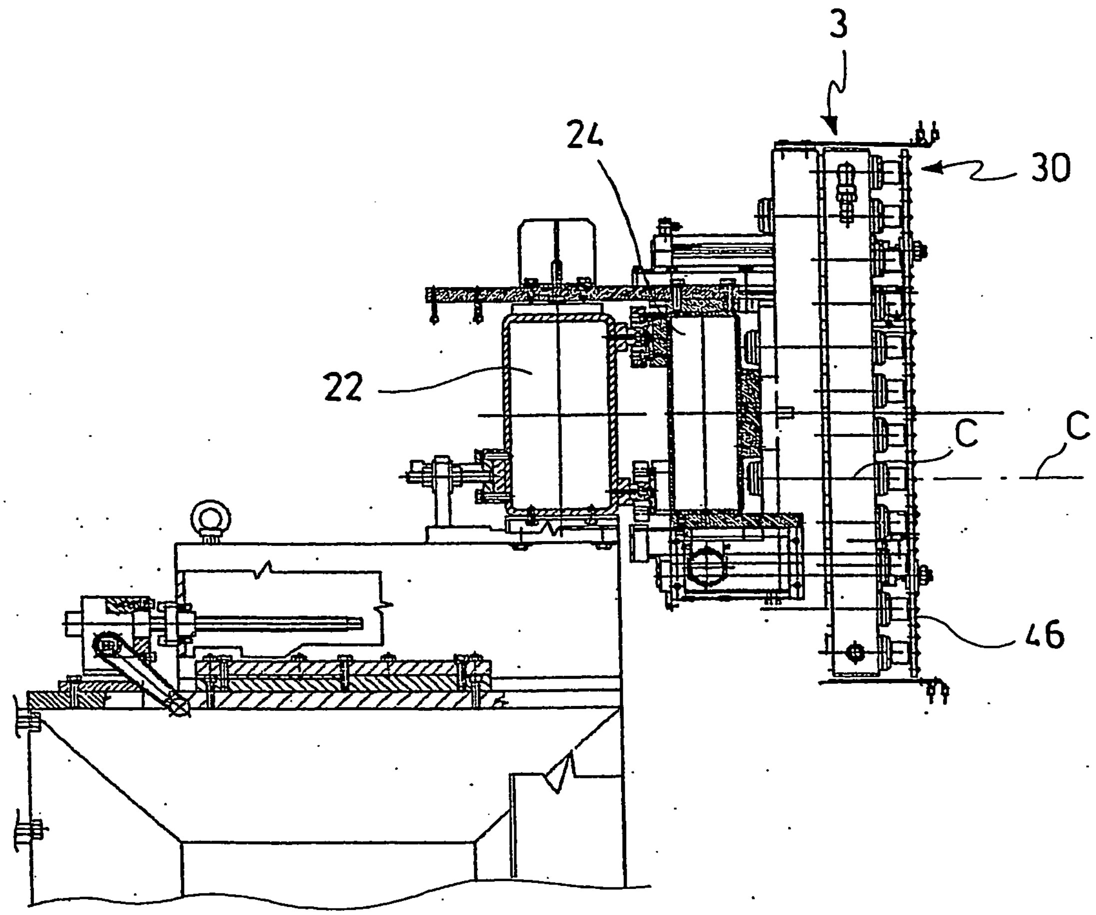



FIG. 6

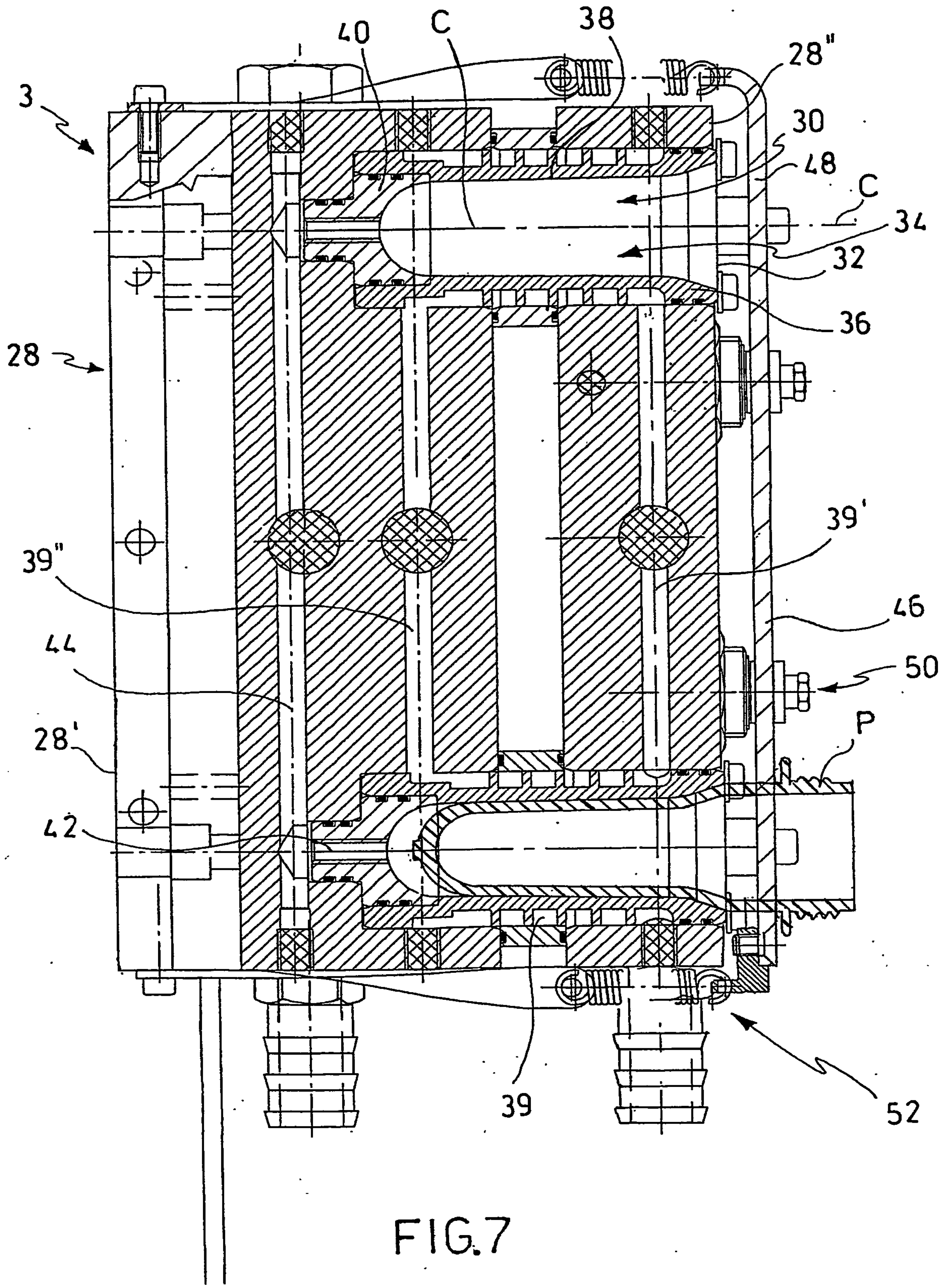



FIG.7

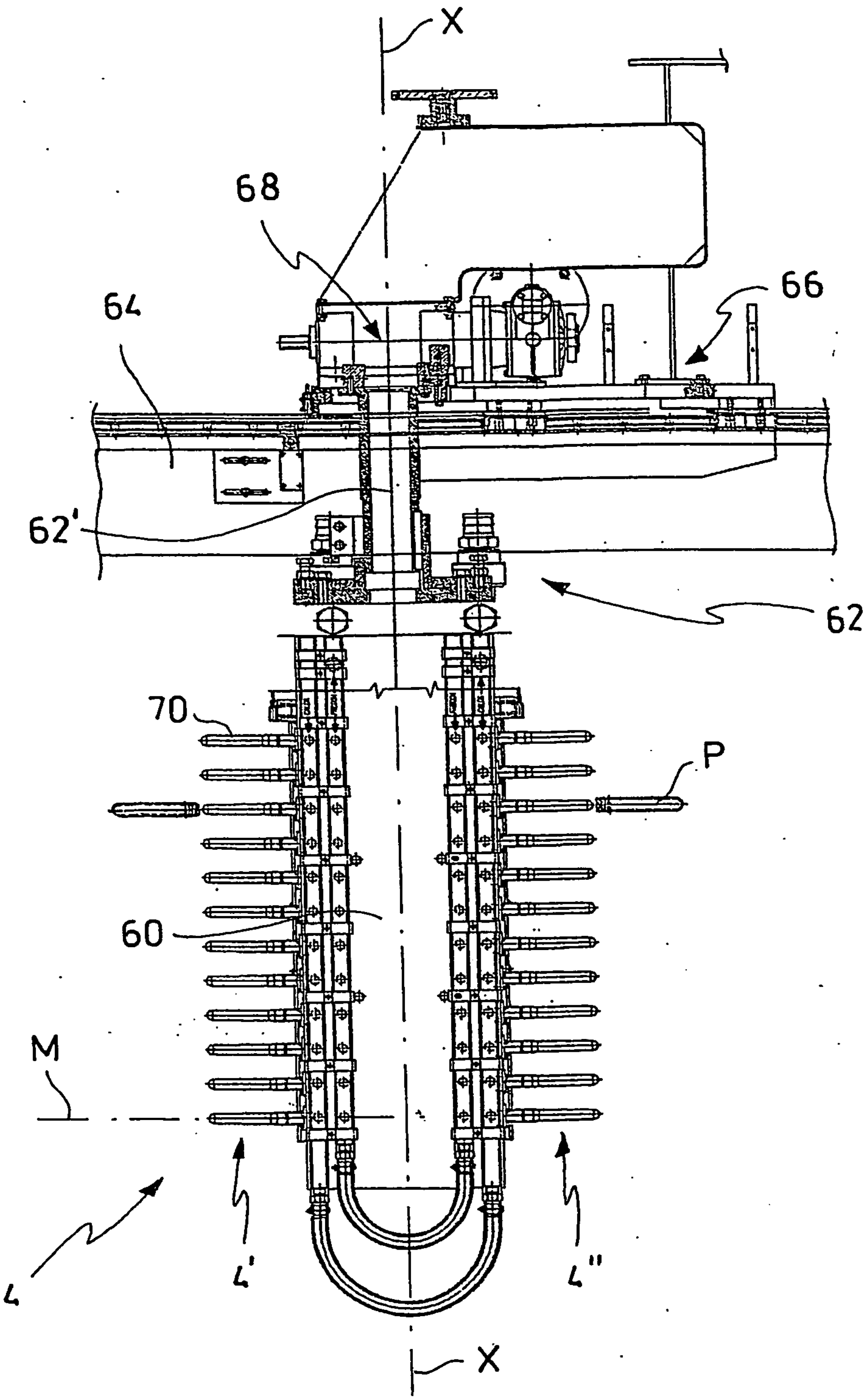



FIG. 8

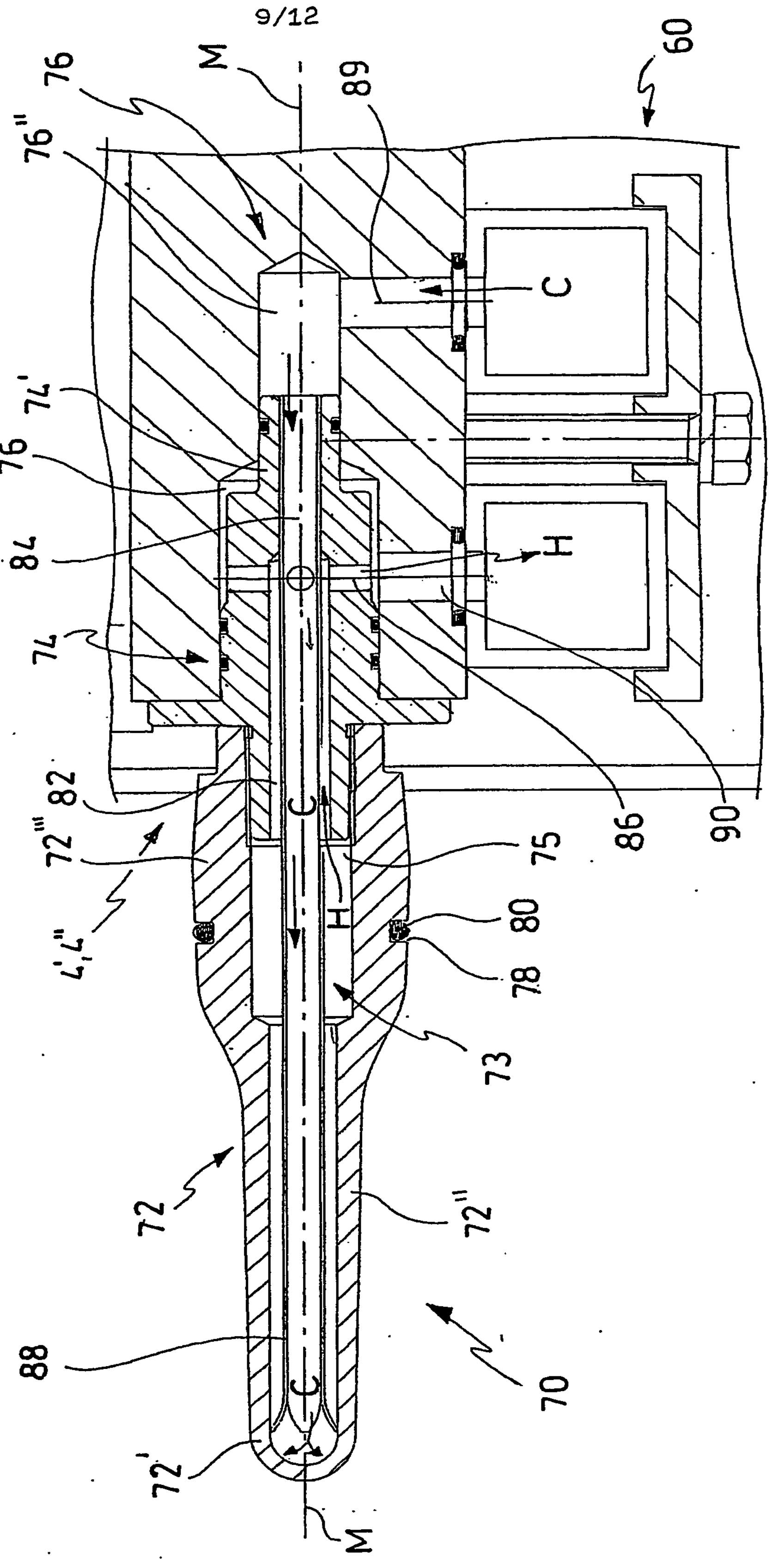

60
76
M
89
76"
C
74'
76'
84
H
74
82
72'''
C
75
H
80
78
L,L"
73
86
90
72
72"
88
C
70
72'
M

FIG. 9

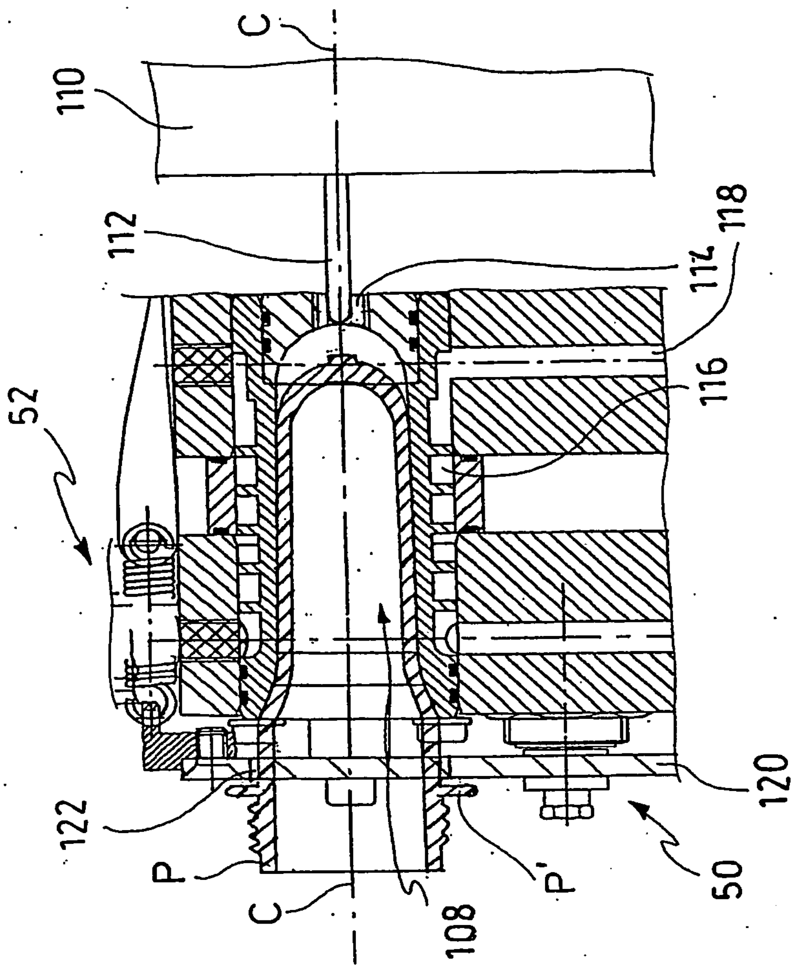

C
110
112
114
118
116
52
122
P
C
108
P'
50
120

FIG.11

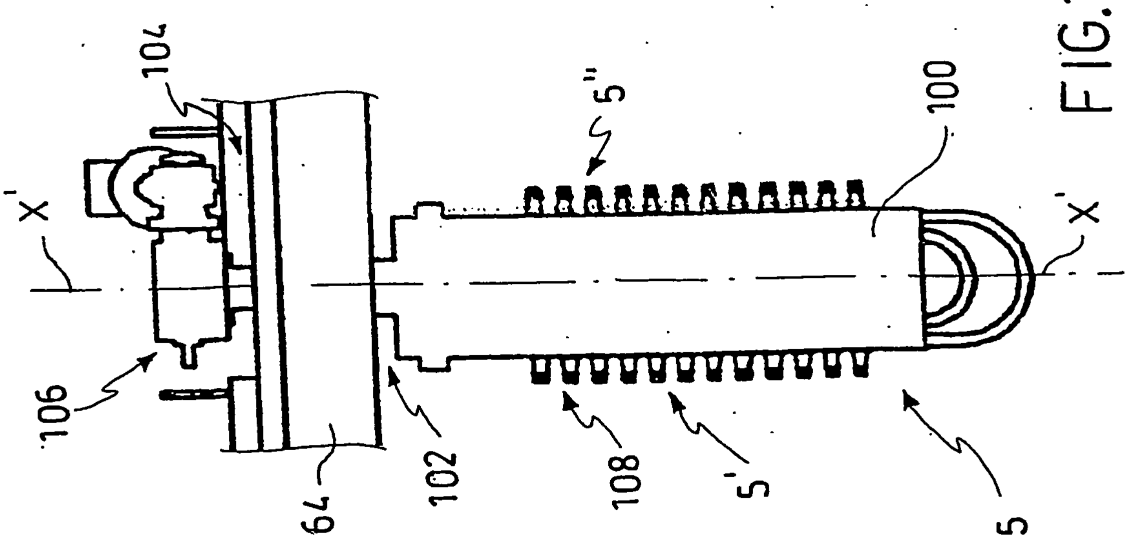
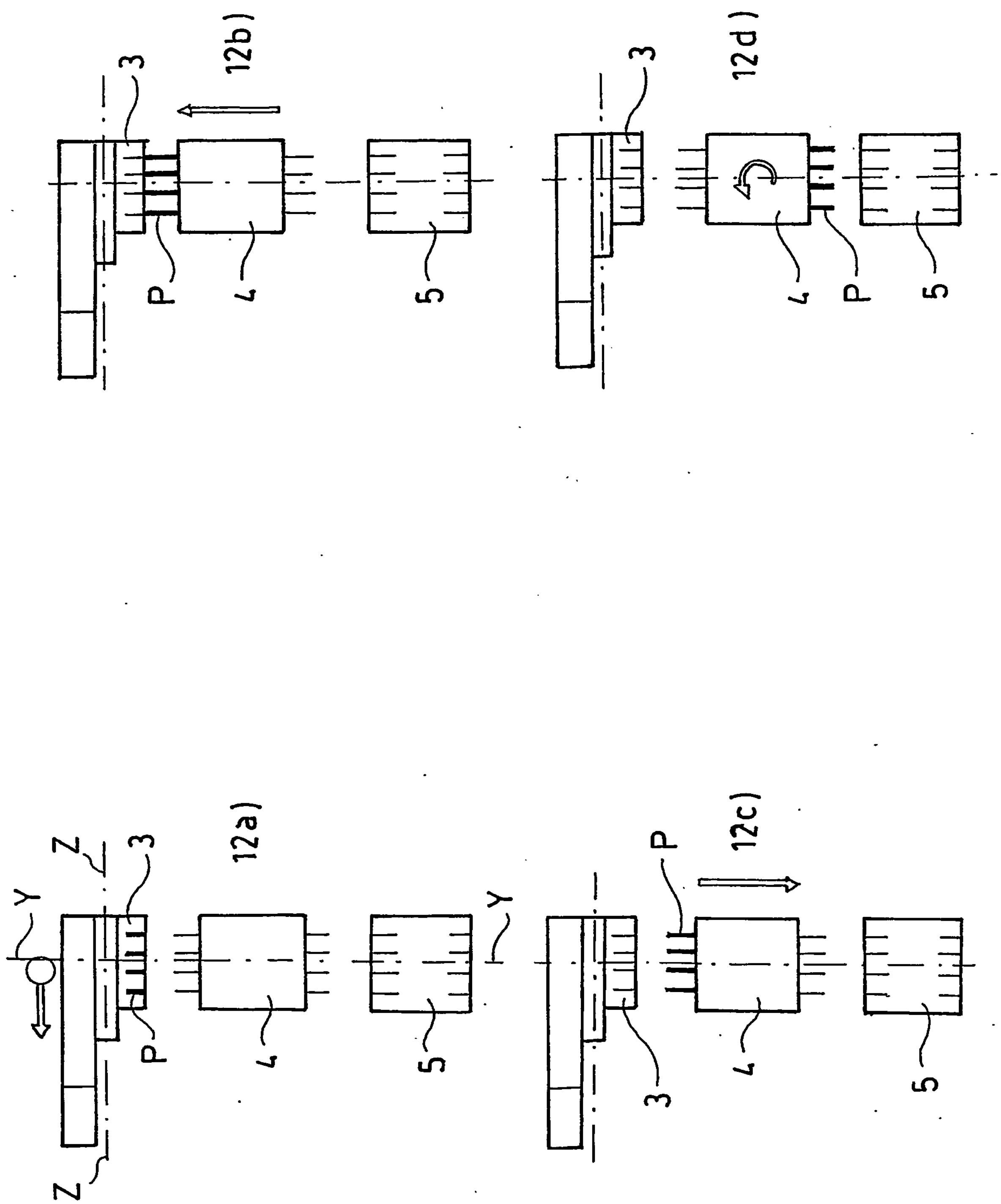

X'
104
106
5''
100
X'
64
102
108
5'
5

FIG.10


12b)
3
P
4
5
12d)
3
4
P
5
12a)
Y
Z
3
P
4
5
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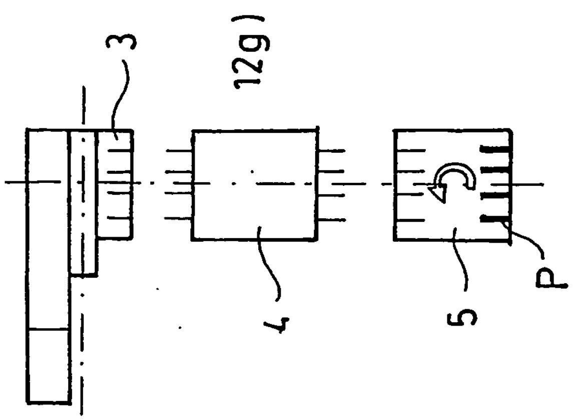
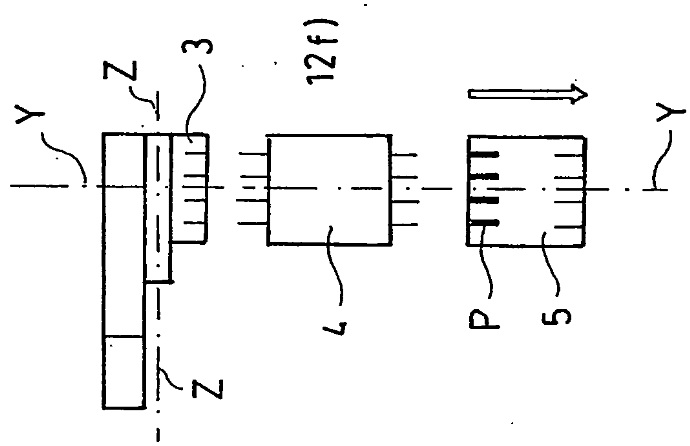
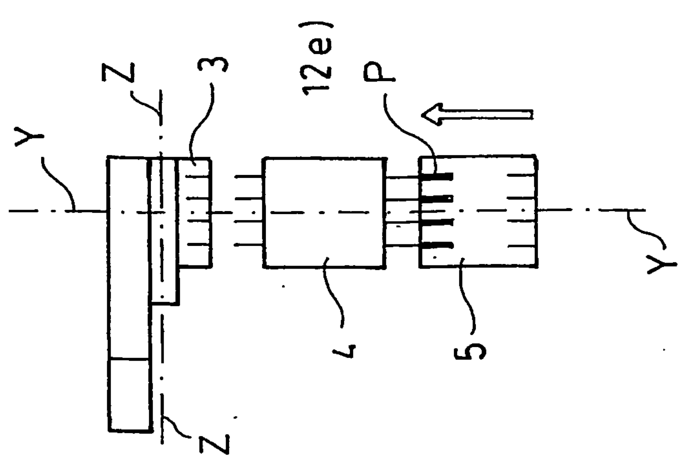
12c)
P
Y
3
4
5



12g)



12f)



12e)

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 01/00543

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 B29C45/72

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| A | | 28 |
| Y | the whole document | 33,34, 36-40 |
| X | US 6 143 225 A (DOMODOSSOLA ROBERT ET AL) 7 November 2000 (2000-11-07) | 1,3-6, 13, 15-17, 43,44 |
| Y | | 18-22 |
| A | the whole document | 28 |
| X | WO 01 19589 A (HUSKY INJECTION MOLDING SYSTEMS) 22 March 2001 (2001-03-22) | 1,3-5, 13,43,44 |
| A | page 5, line 25 - line 37; figure 1 | 28 |
| | -/-- | |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 14 June 2002 | 20/06/2002 |

| Name and mailing address of the ISA | Authorized officer |
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| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Bollen, J |

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 01/00543

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication,where appropriate, of the relevant passages | Relevant to claim No. |
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| Y | EP 0 633 119 A (HUSKY INJECTION MOLDING SYSTEMS) 11 January 1995 (1995-01-11)<br>the whole document<br>----- | 18-22,<br>33,34,<br>36-40 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IT 01/00543

| Patent document cited in search report | | Publication date | Patent family member(s) | | Publication date |
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